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STEREOMICROSCOPE

The invention concerns a stereomicroscope for magnifying a subject by means of at least one zoom through which, in the operating state, a subject beam emitted from the subject is directed. A stereomicroscope of this kind is known, for example, from EP-A2-1 120 676 and from US-A-5 822 114. For better comprehension of this cited existing art, the reader is referred to Fig. 2 of EP-A2-1 120 676, which comprises in large part arrangements similar to those in FIG. 1 of the present invention. The reference numbers of EP-A2-1 120 676 have been largely carried over to the description of the present FIG. 1 and the Parts List, so that one skilled in the art can easily recognize the known assemblage as well as differences with respect to the present invention.

In the design of stereomicroscopes, it is generally desirable to keep the overall height as low as possible, on the one hand in order to minimize the eye-subject distance (i.e. the distance between the observer's eye and the subject being viewed), and on the other hand to achieve – in the event the stereomicroscope is used as a surgical microscope – the smallest and most compact design possible, which is also intended to have a favorable effect on moving masses.

In normal operation of a conventional stereomicroscope that is not in a pivoted position, the beam paths that pass through the main objective and the zoom are arranged approximately vertically.

The aforementioned documents of the existing art indicated as their purpose a reduction in overall height. This was achieved by means of a horizontal arrangement of the zoom. The result was to reduce both the overall height of the microscope and also the eye-subject distance.

The reduction in overall height resulting from this known action is, however, limited, as is also the reduction in the eye-subject distance; the question arising therefrom is whether it is not also possible to achieve a (further) decrease in overall height, and in particular a reduction in the eye-subject distance, by means of actions other than a horizontal arrangement of the zoom.

It is thus the object of the invention further to decrease the overall height and the eye-subject distance of such stereomicroscopes, and thus to improve ergonomic usability.

This object is achieved by a stereomicroscope for magnifying a subject by means of at least one zoom through which, in the operating state, a subject beam emitted from the subject is directed, the stereomicroscope comprising a first optical deflection device, arranged physically behind the zoom in the light direction, for deflecting the light beam directed through the zoom into a direction that deviates by less than 45°, in particular less than 20°, from the direction opposite to the subject beam. This means that the light beam deflected after the zoom once again points approximately in the direction from which the subject beam is coming. The "approximately" extends over a region +/- 45°, or preferably +/- 20°, adjacent to the direction opposite to the subject beam, i.e. in terms of the direction of the subject beam, +/- 135° or preferably +/- 160°. For purposes of the invention, it is not required that the axes of the beams or directions lie within one another; they can also lie next to one another.

It is not necessary, for purposes of the invention, for the first deflection device to be arranged directly behind the zoom. Instead, further deflection devices or optical components, for example lenses, mirrors, prisms, or the like, can be provided between the first deflection device and the zoom. In the case of a stereomicroscope in which a subject beam directed substantially perpendicularly out of the focal plane passes through the optics of the stereomicroscope, the aforesaid object is also achieved, in particular, in that the first deflection device aligns the light beam directed through the zoom in a direction approximately perpendicular to the focal plane. A typical exemplifying embodiment is therefore a deflection into a direction of 180° with respect to the direction of the subject beam, the first deflection device deflecting the light beam directed through the zoom substantially into the direction opposite to the subject beam.

In an advantageous embodiment of the invention, the first deflection device deflects the light beam directed through the zoom substantially toward the subject. The light beam directed through the zoom is deflected, in this context, in such

a way that without further deflection, it would radiate back onto the subject. An exemplifying embodiment of such an embodiment is shown, for example, in FIGS. 1 and 2. Those higher-order embodiments in which return radiation directly back onto the subject would not occur, but instead the back-radiated light beam is merely oppositely parallel to the subject beam (as depicted e.g. in FIG. 3 of the present application), are to be understood as deviating therefrom.

In a further advantageous embodiment of the invention, the stereomicroscope comprises a second deflection device, arranged physically behind the first deflection device in the light direction, for deflecting into an observation beam path the light beam deflected by the first deflection device. That beam path could be arranged, for example, in the case of a horizontal zoom, approximately in the direction opposite to the light beam passing through the zoom, so that both the zoom and the observation beam path are located at approximately the same physical height relative to the main objective and relative to the subject. It is apparent that this represents enormous progress with respect to conventional configurations.

In a further advantageous embodiment of the invention, the zoom is arranged substantially perpendicular to the subject beam, the stereomicroscope comprising a third deflection device, arranged physically in front of the zoom in the light direction, for deflecting into the zoom the subject beam emitted from the subject, the second and the third deflection devices preferably being arranged physically next to one another. This position of the zoom is often referred to among specialists as "horizontal." The third deflection device directs the subject beam out of its perpendicular direction (with respect to the focal plane of the microscope) into the horizontal zoom (located parallel to the focal plane). The physical arrangement of the second and third deflection devices next to one another results in a compact design.

In a further advantageous embodiment of the invention, the deflection devices comprise reflective surfaces having a front side for reflecting light beams and a rear side, the second and third deflection devices being arranged with their rear sides toward one another.

In a further advantageous embodiment of the invention, a tube is arranged physically behind the second deflection device in the light direction, the second and

the third deflection device being embodied pivotably or rotatably in such a way that the subject beam is guidable directly into the tube, bypassing the zoom. In the context of a zoom microscope this makes it possible always to return, by simple mechanical switching of an optical component, to a fixed magnification that is useful as a reference for medical landmark allocation. Click-stop devices on the zoom, which likewise lead back to reference settings, can thus be omitted.

In a further advantageous embodiment of the invention, a mirror layer that reflects light on both sides is arranged between the second and the third deflection device.

In a further advantageous embodiment of the invention, the second deflection device and the third deflection device are embodied together in one piece.

In a further advantageous embodiment of the invention, one of the three deflection devices comprises a roof edge or other devices, for example including an intermediate image system to eliminate an image reversal. On the other hand, it is also possible for such devices to be associated with the deflection devices.

The object cited earlier is also independently achieved by a stereomicroscope improved in this fashion for magnifying a subject by means of at least one zoom through which, in the first operating state, a subject beam emitted from the subject is directed by means of a (third) deflection device into the zoom; the stereomicroscope comprising a further (second) deflection device, arranged physically behind the zoom in the light direction, for deflecting the deflected light beam into the opposite direction from the light beam coming from the subject and directed into the zoom; a second operating state being implementable by the fact that the further (second) deflection device ends up physically in front of the zoom in the light direction and directs the subject beam away from the zoom; the deflection device and the further deflection device being arranged physically next to one another, preferably embodied in integral fashion, and pivotably or rotatably.

A particular embodiment of this independent invention in fact uses only a single rotatable or pivotable deflection device, which implements the function of the (third) deflection device only in the first operating state, and the function of the (second) further deflection device only in the second operating state.

Further embodiments of the invention and variants thereof are described in the dependent claims.

The Parts List and the drawings are, together with the features described in the claims, an integral constituent of the disclosure of this application.

The Figures are described in continuous and overlapping fashion. Identical reference characters denote identical components; reference characters with different indices indicate functionally identical components.

Further advantageous embodiments are evident from the schematic drawings, in which:

FIG. 1 shows an exemplifying embodiment of a stereomicroscope according to the present invention;

FIG. 2 shows a detail of the exemplifying embodiment of FIG. 1, specifically the particularly advantageous arrangement of a first, a second, and a third deflection device;

FIG. 3 shows a further exemplifying embodiment of an arrangement according to the present invention of a first, second, and third deflection device;

FIG. 4 shows a further exemplifying embodiment of an arrangement according to the present invention of a first, second, and third deflection device;

FIG. 5 shows a further exemplifying embodiment of an arrangement according to the present invention of a first, second, and third deflection device; and

FIG. 6 shows a further exemplifying embodiment of an arrangement according to the present invention of a first, second, and third deflection device.

FIG. 1 shows, as an exemplifying embodiment, a stereomicroscope 1 according to EP-A2-1 120 676, although modified in accordance with the present invention. Reference characters identical to those in FIG. 2 of EP-A2-1 120 676 designate identical or similar components of the assemblage. For reasons of simplicity, only one simultaneous observation tube for an assistant 27 is depicted. T designates a subject or the focal plane that emits a subject beam K1. This subject beam K1 passes through a connector 7A and then into an opening 3 in a housing 2 and into stereomicroscope 1 and its objective 21, and before that is split, if applicable, by means of an optional beam splitter B1, one portion of subject beam K1 being

diverted, if applicable, into a beam path (not shown further), and a further portion of the subject beam traveling through the aforesaid opening 3 and through lenses L2 onto a deflection device P1.

Deflection device P1 is an example of a third deflection device as defined in the claims and the introduction to the specification. After deflection device P1, light beam A1 passes through a horizontal zoom 22. Light beam A1 emerging from zoom 22 encounters, along the extension of zoom 22, a further beam splitter B2 with which the light beam is split in such a way that one portion is guided into a simultaneous observation tube 11 for an assistant 27, and another portion is guided as light beam A2 into a deflection device P2. Light beam A2 is directed by means of deflection device P2 onto a further deflection device P4 that represents an example of a first deflection device as defined in the claims and the introduction to the specification. Deflection device P4 deflects light beam A2 onto a further deflection device P5 (cf. light beam A3), from which the light beam, now designated A4, is further directed into a tube 4 and an eyepiece 5 for a principal observer 26.

Deflection device P5 is an example of a second deflection device as defined in the claims and the introduction to the specification.

Deflection devices P1, P2, P4, and P5 are advantageously embodied as prisms, but are not limited thereto.

As is clearly evident, as a result of the invention and the utilization of first deflection device P4, tube 4 and eyepiece 5 are located closer to the main objective and to subject T than in the case of the known assemblage according to EP-A2-1 120 676. The eye-subject distance, and also generally the overall height of microscope 1, are thus further reduced.

Stereomicroscope 1 additionally comprises a fiber optic cable 14 or light source by means of which light can be guided through a illumination system 13 via a mirror M1 onto subject T. A device 12 for reflecting an image of a monitor 25 through a lens L4 into the beam path of stereomicroscope 1 is also optionally provided.

FIG. 2 shows in detail the arrangement of deflection devices P1, P4, and P5 of FIG. 1 with respect to one another. As in FIG. 1, A1 designates the light beam

entering zoom 22, and A2 the light beam entering first deflection device P4. A3 designates the light beam that emerges from deflection device P4 and enters second deflection device P5. A4 designates the light beam proceeding out of deflection device P5.

In the configuration according to FIG. 2, deflection devices P1 and P5 are arranged in such a way that they rest with their rear sides against each other. S designates an optionally provided double-sided mirror layer between the rear sides of the two deflection devices P1 and P5, subject beam K1 being deflected into a light beam A1, and light beam A3 into light beam A4.

Even in a configuration without a mirror layer, e.g. involving total reflection, deflection devices P1 and P5 are to be embodied in such a way that subject beam K1 and light beam A3 are totally reflected, or at least embodied so that passage of rays through P1 and P5 is prevented, e.g. by way of a partition.

In a particularly advantageous embodiment of the invention that is also usable independently of the other assemblages, provision is made for the arrangement made up of deflection devices P1 and P5 to be configured rotatably, in such a way that subject beam K1 is reflected to constitute a light beam A4, i.e. so that when necessary, the light from subject T is incident directly into tube 4 for the principal observer 26, bypassing zoom 22. The result of this is that a user of the stereomicroscope can, without adjusting zoom 22, very easily switch from low magnification to high magnification and vice versa, with the ability to the use the lower magnification, for example, as a reference magnification. The switched-over state is indicated in FIG. 2 by the dashed line S', which shows mirror surface S when deflection devices P1 and P5 are rotated. In this position, as is apparent, subject beam K1 transitions directly into light beam A4 that is used as the observation beam.

FIG. 3 shows a further exemplifying embodiment of the arrangement of deflection devices P1, P4, and P5. In contrast to the exemplifying embodiment according to FIG. 1 and FIG. 2, here deflection devices P1 and P5 are not physically arranged immediately next to one another. With this configuration, tube 4 can be located even lower, since second deflection device P5 is not dependent on third deflection device P1 and can thus also be placed lower down, as is apparent in FIG. 3

from the lower position of light beam A4 as compared with light beam A1. The eye-subject distance can thus be shortened almost arbitrarily. Irrespective of this, deflection device P5 can be pivotable, as indicated by pivot arrow 28.

In addition, the pivotability, known per se, of tube 4 and/or eyepiece 5 further enhances ergonomics.

FIG. 4 shows a further exemplifying embodiment of an arrangement of deflection devices P1, P4, and P5. Here, in contrast to the exemplifying embodiment according to FIG. 3, deflection devices P4 and P5 are configured in such a way that they do not reflect light at a right angle. Unlike in the exemplifying embodiments according to FIGS. 1, 2, and 3, in which light beam A3 proceeds in the direction opposite to subject beam K1, in the exemplifying embodiment according FIG. 4, light beam A3 is inclined at an angle α with respect to subject beam K1. Angle α is smaller than 45°, preferably smaller than 20°. The smaller the angle, the closer deflected light beam A3 comes to proceeding in the direction opposite to subject beam K1. As angle α becomes smaller, the size of deflection element P4 can be correspondingly smaller. The oblique position of deflection device P5 with respect to light beam A3 is depicted only by way of example. It could assume different angular positions, and thereby influence the ergonomics for attachment of an observation tube.

FIG. 5 shows a further exemplifying embodiment of the arrangement of deflection devices P1, P4, and P5. Here, in contrast to the exemplifying embodiment according to FIG. 3, deflection device P5 is embodied e.g. as a pentaprism or as a prism having a roof edge, thereby enabling an image reversal. Details of such prisms for image reversal or for preventing image reversal may be obtained from the book by Naumann/Schröder, "Bauelemente der Optik" [Optical components], Taschenbuch der technischen Optik, 5th ed., page 162.

FIG. 6 shows a particularly advantageous exemplifying embodiment of an arrangement of deflection devices P1, P4, and P5. Here, in contrast to the exemplifying embodiment according to FIG. 2, deflection device P4 is configured as a pentaprism. It could also be configured as a prism having a roof edge, to prevent an image reversal produced by an odd number of preceding deflection elements and intermediate image elements. The result of this is that light beam A4 does not furnish

a mirror-reversed image of subject T, even though, in contrast to the exemplifying embodiment according to FIG. 5, the particularly advantageous arrangement of deflection devices P1 and P5 with respect to one another is retained.

PARTS LIST

1	Stereomicroscope
2	Housing
3	Opening
4	Tube
5	Eyepiece
7A	Connector
11	Assistant's tube
12	Device for reflecting in the image of a monitor (25)
13	Illumination system
14	Fiber optic cable
21	Objective
22	Zoom
25	Monitor
26	Principal observer
27	Assistant
28	Pivot arrow
A	Light beam (A1, A2, A3, A4)
B	Beam splitter (B1, B2)
B3	Optional beam splitter for lateral reflection out of the image plane
K1	Subject beam
K3	Observation beam path for (27)
L	Lenses (L2, L4)
M1	Mirror
P	Deflection device(s) (P1, P2, P4, P5)
S	Mirror layer
S'	Rotated mirror layer
T	Subject or focal plane
α	Angle between direction (-K1) opposite to direction (K1) and light beam (A3) (FIG. 4)